Design and Testing of a Fullerene RF Ion Engine

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Abstract

Because of the large mass, low ionization potential and large electron impact ionizat ion cross-section use of Buckminste rfullerene (C_{60}) as a propellant might result in significant increases in ion engine e fficiency over that obtained with xenon at low specific impulse. Consequently, an experimental program to investigate the feasibility of using fullerenes as a propellant was initiated. Data obtained during experiments conducted with a DC discharge ion source indicate. the presence of C_{60} ions, as well as lower molecular weight ions, being, extracted from the ion source. other experiments demonstrated that C_{60} dissociates at high temperatures. "1'0 eliminate the possibility of hot cathode surfaces causing fragmentation, fabrication of a radio frequency (RF) discharge chamber was pursued. The discharge chamber consists of a cylindrical quartz vessel with the. extraction grid system and an oven containing the fullerene propellant flanged to opposite ends. An RF coil wrapped around the outside of the quartz vessel induces an azimuthal electric AC field inside, the chamber. The fullerene plasma is heated inductively, dominating, the need for hot electrode surfaces inside the discharge chamber. The coil is matched to an RF generator via a capacitive, matching circuit to reduce reflective RF losses from the engine. ignition of the discharge may be obtained by RF breakdown or with the aide of neut ralizer electrons at tracted into the discharge chamber by temporarily applying a positive voltage to the screen grid. The RF field will further accelerate these electrons inside the discharge chamber, leading to breakdown.

Experimental results obtained using the RF source. will be presented. During the. initial test phase of the RF engine using fullerene propellants, attention will focus on the determination of beam composition and plume diagnostics. Of particular interest is the investigation of potential fullerene fragmentation. An ExB mass spectrometer will be used to determine the species extracted from the plasma, The relative concentration of contaminants and fullerene fragment ions extracted from the plasma can be deter mined from data obtained with this probe. Plume diagnostics will be conducted using a Faraday probe which is swept through the extracted ion beam to obtain current density profiles. in addition, a retarding potential analyzer will be used to determine the energy of the extracted ions.